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PROGRESS REPORT

of the

STANDARDS AND RESEARCH DIVISION

STATISTICAL REPORTING SERVICE

This progress report includes a summary of the current research of the Division and a preliminary report of progress made during the preceding year. It is primarily a tool for use of scientists and administrators in program coordination, development and evaluation; and for use of advisory committees in program review and development of recommendations for future research programs.

The summaries of progress on USDA and cooperative research include some tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed, will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to members of Department staff, advisory committee members and others having a special interest in the development of public agricultural research programs.

This report also includes a list of publications reporting results of USDA and cooperative research issued between July 1, 1967, and June 30, 1968. Current agricultural research findings are also published in the USDA publications, Agricultural Economics Research and Farm Index. This progress report was compiled in the Standards and Research Division, Statistical Reporting Service, U.S. Department of Agriculture, Washington, D.C.

UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D.C.

July 1, 1968



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## INTRODUCTION

The Statistical Reporting Service administers crop and livestock estimating programs designed to provide current information about crop acreages and production, livestock numbers, and other statistics pertaining to the agricultural economy. The research activities of SRS are centered in the Special Surveys and the Research and Development Branches of the Standards and Research Division. Both branches perform some service as well as research activities.

The Special Surveys Branch conducts research on the behavior, opinions, and preferences of consumers which affect their purchase and use of agricultural products or end products.

The Research and Development Branch conducts research on sampling and survey methods as applied to the data collection activities of SRS, and development of techniques of statistical measurement applicable to substantive research.

The work of these branches is being performed by a staff of about 17 professional employees. Part of the research is conducted by contract with private research organizations and cooperative agreements with land grant colleges or producer and processor groups. On occasion, funds are transferred to the division by other government agencies or farm organizations to finance special research studies undertaken at their request.

Results of studies conducted by the Special Surveys Branch on consumers' opinions of agriculturally-produced materials in various end uses have been used by natural fiber organizations to evaluate the position of cotton and wool in specific segments of the textile industry, and to encourage and guide USDA and private industry efforts to improve the attributes of natural fibers so that they can compete more successfully with synthetics. In addition, each year the National Cotton Council of America bases a major portion of its promotion for consumers and retailers on these research results.

The results of a study of acceptance by a panel of consumers of instant sweetpotato flakes, which were developed by the Southern Utilization Research and Development Division, ARS, indicated considerable commercial potential for the new product. This conclusion is similar to that drawn from the results of an earlier study to measure consumers' reactions to instant white potato flakes. The acceptance of the white flakes has been a major contributing factor to halting the downward trend of per capita potato consumption. Since the publication of the final results of the sweetpotato flakes survey, a number of processors have begun producing the sweetpotato flakes.



The Special Surveys Branch has also conducted a number of studies in cooperation with the Economic Research Service to evaluate the market potential for products developed by the USDA's Utilization Research Regional Laboratories. One of these projects indicated that a new super-concentrated apple juice, which was processed so that fruit juice aromas which would otherwise be lost were recovered, was well received by household consumers in a test market. The firm that cooperated with the Department in the market test subsequently undertook production of the juice with some variations from the original process. Preference tests in the Special Survey Branch's Sensory Evaluation Laboratory indicated that the variant product was much less acceptable to consumers than juice prepared by the original process. Market tests of the variant product were therefore discontinued pending further technical research.

The improved survey methods developed by the Research and Development Branch are being put into operation by SRS as rapidly as resources will permit. In June 1968 the enumerative survey program was continued in all the 48 conterminous states at an operating level. Operational objective yield surveys for corn, cotton and wheat were also conducted--corn in 30 states, cotton in 14 states and winter wheat in 15 states. Objective yield work for soybeans, which was done in 15 major states, was directed toward full scale testing of the forecast models previously developed. The research program which produced the methodology for this survey will be incorporated into the operating program of SRS in FY 1969. Work is being continued both in survey methods and in objective yield methods for field and fruit crops.



AREA NO. 1: CONSUMER ATTITUDES AND PREFERENCES

(RPA 508 - DEVELOPMENT OF DOMESTIC MARKETS FOR FARM PRODUCTS)

USDA Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Washington, D.C.	Livestock	1.4
Washington, D.C.	Fruits	1.7
Washington, D.C.	Vegetables and Grains	.5
Washington, D.C.	Cotton	.4
Total		4.0

Intramural program is supplemented by extramural support representing 3.9 SMY's at private market research firms.

## Problems and Objectives

Domestic consumption of agricultural commodities depends on the behavior of some 200 million consumers. But, in our complex marketing economy, it has become almost impossible for consumers to discuss their opinions, preferences, and complaints with producers and marketers. Knowledge of consumer reactions to agricultural products is becoming increasingly important because we are in a period of rapid change: There is a growing challenge to farm products and farm income from a wide variety of competitive products of nonagricultural origin; there is a proliferation of mixtures, forms, processes, blends, and other innovations affecting farm products; there is an increasing awareness of the adverse effects incorrect decisions made as a result of inadequate information on the consumer's viewpoint can have on USDA functions as well as farm income.

Major objectives of this market development research are to provide the following in a scientific and unbiased manner:

1. A line of communication from consumers back to those concerned with production, processing, and marketing farm products.
2. Identification of areas on which technical research should focus to provide farm products with characteristics that will increase consumer acceptance.
3. Evaluation of consumers' reactions to specific product variations under controlled laboratory conditions.
4. Assessment of consumers' knowledge and opinions concerning Department functions such as educational programs, setting grades and standards, and inspection of farm products.

## Progress--USDA Program

### A. Livestock

1. Meats - A nationwide sample of homemakers was interviewed during 1967 to ascertain their opinions and usage patterns for various meats and meat products. Much of the questionnaire was oriented toward uncovering some of the reasons that underlie increased per capita consumption of beef on one hand and decreasing consumption of pork on the other. A preliminary report based on some of the data from interviews with 776 homemakers in the first quarter of 1967 has been published; a final report incorporating results from all four quarters of interviewing is being prepared. The National Livestock and Meat Board is cooperating with the Statistical Reporting Service on this study, and has provided a substantial portion of the funds for the contract.

Findings related to consumers' attitudes and opinions show that beef--considered either generically or by specific cuts--is viewed favorably by homemakers on characteristics such as flavor, digestibility, and versatility, and is the most popular meat for a variety of situations when compared to chicken, ham (smoked or cured pork) and lastly, fresh pork. More homemakers reported serving fresh pork than ham, however.

The most frequent complaints homemakers directed at meat in general concerned packaging; complaints centered around their inability to see the amount of waste in a package. Another form of merchandising viewed with disfavor by homemakers was retailing raw meat already frozen. Lack of means for determining the freshness of such meat was claimed to be the primary deterrent to its purpose.

Purposes of USDA grading and inspection are not clear to consumers. Many of them think that the functions of grading include those of inspection, and vice versa. Apparently many consumers also assume that all kinds of meat are graded by the U.S. Department of Agriculture; although the large majority correctly stated that beef is graded, about half the respondents had the erroneous impression that pork is graded.

2. Frankfurters - Sensory evaluation experiments were conducted to determine the relative preference for two experimental samples of frankfurters containing chicken (15 percent and 25 percent) and a commercial brand of all-meat frankfurter which contained no chicken. The results showed that the frankfurters containing 25 percent chicken were significantly preferred to the all-meat control; however, there were no significant differences between the 15 percent and 25 percent of the 15 percent chicken and the all-meat frankfurters.

3. Leather - A survey was conducted among over 500 men and 500 women in the Philadelphia, Penna., area to ascertain the attitudes and opinions of consumers concerning leather, primarily in shoe uppers. The study investigates consumers' opinions about the advantages and disadvantages of leather compared to competing synthetic products, and their impressions of the desirability of potential improvements in leather for shoes. Attitudes toward leather in clothing are also being studied, again in comparison with competing synthetics currently on the market. Data collection is completed; the results are currently being analyzed.

4. Dry Whole Milk - A powdered product developed by ARS which reconstitutes into fluid whole milk, was tested by a sample of over 300 households in the Alexandria, Virginia area. Considering overall needs and preferences, the dry whole milk was rated equal to or better than fresh whole milk by 4 out of 10 of the participating homemakers. About three-fourths of the homemakers found advantages to the dry whole milk--the most frequently mentioned advantage was that it was lightweight and easy to store; the most frequently mentioned disadvantage was that the test milk takes time to prepare or mix.



The consumer survey phase of a small-scale market test is being conducted in cooperation with ERS-MED to further investigate acceptance of another experimental dry whole milk manufactured by a different process.

## B. Fruits

1. Nationwide Citrus Study - Information has been gathered from a nationwide sample of homemakers on their experiences, beliefs, attitudes, and criticisms of citrus and citrus products, as well as the impact of synthetic products on their attitudes toward natural fruit products. Small-scale exploratory activity was conducted prior to the main survey to assure that major issues related to attitudes toward the purchase and use of citrus that might otherwise be overlooked were covered in the full-scale survey, or at least identified for consideration. The citrus fruits asked about in the questionnaire are oranges, grapefruit, and lemons. Juices from these fruits are also covered. The field interviewing was concluded in June 1968, and the coding phase is now in progress.

2. Instant Grapefruit and Orange Juices - Preliminary results have been released on a study to evaluate consumer acceptance of foam-mat dried grapefruit juice crystals, which was financed in part by the Florida Citrus Commission and the Fruit and Vegetable Lab of the Agricultural Research Service, which developed the product. The survey indicated that the concept of this new product was well received, but that the chances of successfully marketing the grapefruit juice crystals would be enhanced if the flavor were improved and if the crystals could be made to dissolve a little more easily. A more detailed report on these results is being prepared for publication.

Experiments conducted recently on storage stability of orange juice crystals suggest that the Fruit and Vegetable Products Laboratory may have solved the shelf-life problem for this product--there was no significant difference between the mean preference scores for samples stored at 85°F for 6 months and samples which had not been stored at all.

Another series of experiments on instant orange juice showed that there was no significant difference in subject preference ratings between juices sweetened with calcium cyclamate or sucrose. However, both of these sweetened juices were preferred to the unsweetened juice. However, further sensory evaluation work on the instant orange juice in comparison with two synthetic orange flavored drink powders currently on the market indicated that the orange crystals would also be more appealing to consumers if the flavor were improved, since it did not compare favorably with the synthetics.

In a later study conducted on samples of orange juice reconstituted from frozen concentrate, there was again no significant difference in preference ratings between the calcium cyclamate and sucrose sweetened juices. This study was conducted at the request of the Florida Citrus Commission, which

is working with industry to develop improved orange juice products. Ten different frozen concentrates varying in Brix/acid ratio and the type and amount of sweetener added--sucrose or calcium cyclamate--were selected. These juices were rated to determine which of the artificially sweetened products would have the greatest flavor appeal to consumers and whether it would compare favorably with the sugared and naturally sweet juices at the same Brix/acid ratio. The results of this test provided a basis for selecting the product to be used for a market test by the Commission on artificially sweetened orange juice.

The same industry groups have embarked on a program of improving canned single strength orange juice which they hope will make this product more appealing to consumers. A series of tests were conducted to investigate people's reactions to variations in factors such as brix/acid ratio, storage conditions and the particular variety or combinations of varieties of oranges from which the canned juices were manufactured. The most striking finding of the study was that almost invariably the higher the brix/acid ratio, the higher the preference rating. It was also found that canned single strength orange juice stored over a long period of time in a cold location (40°F) was significantly preferred to juice from the same pack which had been stored under unfavorable temperature conditions such as might be found in many warehouses (80°F).

3. Peel Oil Levels in Orange Juice - A contract, financed in large part by ARS, has been signed with a private market research firm to investigate consumer acceptance of frozen concentrated orange juice at different peel oil levels to obtain insights into the effect which variations in peel oil levels have on preferences. A related study will be conducted in the SRS Sensory Evaluation Laboratory to augment the research conducted by the contractor.

### C. Vegetables and Grain

1. Potatoes, Rice and Wheat - The final report is being prepared for publication for a nationwide study among homemakers on their use of and opinions about selected potato, rice, and wheat products. Almost all of the homemakers interviewed reported that they had used white bread and some form of white potatoes and rice during the year preceding the interview. In general, the homemakers felt that fresh white potatoes, regular uncooked rice, and bread were high in food value, fattening, and low cost per serving.

Among respondents who said they had used some processed potato or rice products, the feeling for the most part was that these products were higher in cost per serving than if prepared "from scratch" by the homemakers, but they were used primarily because they were easier or quicker to prepare.



#### D. Cotton and Other Fibers

1. Women's Clothing - The report was issued recently on a nationwide survey among women about their readymade clothing for wear primarily during warmer weather. Cotton was reportedly the dominant fiber in ownership and preference for all the items studied, except for slips, where nylon was the leader. All cotton implies to consumers a number of important benefits, such as good appearance, washability, and being cool and lightweight. The major weakness in the image cotton projected was that cotton clothes were believed to require too much ironing, and were not perceived as being wrinkle-resistant.

About half of the respondents reported they were aware of machine-washable wool; however, only one-tenth said they owned a garment made of this fabric. Those who said they owned garments that were made of machine-washable wool felt they were easy and economical to care for, but did not keep their shape. Supplemental analyses are being conducted on these data to expand insights into the issues that underlie women's fiber preferences in specific clothing items through a detailed examination of the interrelationships among the reasons given for fiber preferences as well as general attitudes toward fibers. These analyses will be of value in interpreting data already collected as well as in planning future studies.

2. Household Textiles - A contract has been signed with a private research firm to gather information from a national sample of homemakers on their experiences, beliefs, attitudes, and criticisms concerning cotton, wool, and competing fibers in selected household items. Small scale exploratory activity will be conducted prior to the main survey to assure that major issues related to the purchase and use of selected household items, that might otherwise be overlooked or distorted, are covered in the full scale survey. The items currently being considered for coverage in the questionnaire are sheets, blankets, curtains or draperies, table coverings, small and room size rugs and retail piece goods. The field work on the main survey is tentatively planned for early 1969.

#### E. General

1. Food Preservation - A small scale exploratory project involving in-depth group interview sessions will be conducted, under a contract signed recently, among 50 or 60 household consumers to gain insights into their attitudes and opinions concerning foods preserved or processed by selected methods. The sessions will include discussions of relatively new methods of food preservation currently being employed or considered, such as foam mat drying, freeze drying, and irradiation, as well as methods such as freezing which are accepted in some food products (frozen orange juice, for example) but are not favored by homemakers when applied to other commodities.

## F. Service Activities

1. Library Study - Planning has been completed on a survey to be conducted among recipients and potential recipients of the Pesticides Documentation Bulletin, a publication of the National Agricultural Library, as part of an evaluation of the effectiveness of this publication. The study was requested by the Bureau of the Budget in connection with authority for continued publication. The library is reimbursing the Statistical Reporting Service for major expenses incurred in connection with this study.

Publications - USDA Program

### Livestock

Weidenhamer, M., Knott, E. M., and Sherman, L. R., 1968. Homemakers' Opinions about Selected Meats: A Preliminary Report. SRS-12.

### Fruits

Weidenhamer, M., 1967. A Review of Consumer Research on Citrus Products Conducted by the Statistical Reporting Service. Presented at the ARS 1967 Conference on Citrus Chemistry and Utilization.

### Cotton and Other Fibers

Skelly, F., Goldberg, R., and Clayton, L. Y., 1968. Women's Attitudes Toward Cotton and Other Fibers used in Wearing Apparel. Marketing Research Report No. 820.



AREA NO. 2: STATISTICAL METHODS

USDA and Cooperative Program

Location of Intramural Work	: Scientist Man-Years F.Y. 1968		
	: Research Problem Area		: Total
	: RPA 511	: RPA 113	:
Washington, D.C.	: 10.3	: 0.7	: 11.0

Intramural program is supplemented by extramural support representing about 2 SMY's at three State Agricultural Experiment Stations.

## Problem and Objectives

The Statistical Reporting Service prepares a large number of official estimates that are published in the more than 700 reports each year. The critical need for precision estimates for the planning of agricultural policy, agricultural business and industry activities, and individual farm operations or enterprises related to the agricultural economy, makes it imperative that modern statistical theory and methods be developed and incorporated into the collection and preparation of agricultural statistics. Many new techniques have been developed and introduced into current estimating procedures.

The research objectives in survey methods are associated with the improvement of all aspects of survey design. These include questionnaire design, universe definition, sampling frame construction, sample design and estimation, enumeration techniques, quality checks, editing procedures, methods of processing data, the post-analysis of the survey data and evaluation of survey procedures. Activities in these areas are directed toward the improvement of sampling and operational designs. In the current program, priority is being given the investigation of sources of lists for farm operators and processors of agricultural products, maintenance and optimum use of these lists as sampling frames for probability sampling, and the problem of developing methodology for collecting data by mail and enumeration in the same sample survey, using lists in conjunction with area frames.

Progress - USDA and Cooperative Program

### RPA 511 - IMPROVEMENT OF AGRICULTURAL STATISTICS

#### A. Crop Yield Forecasting and Estimation

1. Soybeans - Activity during the 1967 season was largely directed toward full scale testing of the forecast models previously developed and to evaluating the effect on productivity resulting from physically handling plants in the sample units while making monthly counts. Additional work was also carried on to clarify the definition of maturity categories and to improve the model used for predicting the weight of beans per pod at harvest.

A total of 1,670 samples were allocated to 15 major states for monthly pre-harvest survey observations. Of these, 876 were also scheduled for a post-harvest interview and field gleanings to determine harvest losses. In addition, two experimental units were located midway between the two regular plots in every tenth sample field. Observations taken in the first experimental unit included all of the regular monthly counts plus additional counts of fruit buds and of pods by size groups. No observations

were made in the second (or control) unit until the field was mature and ready for harvest. Observations in the two special units in each tenth field were used to determine to what extent the yield potential of the sample units was affected by the handling required in making the monthly observations on immature plants. Factors considered were the number of surviving plants, the number of pods with beans per plant, and the average weight of beans per pod. Comparisons of observations in the two experimental units, and of counts in the control unit with counts in the regular sample units in the same field, revealed no consistent differences for any of these factors.

Information on acreage remaining for harvest as beans was obtained for 1,597 samples as part of the first visit to the sample field. Operators of the remaining 73 sample fields refused to supply any information or to allow their fields to be used in this survey. Preharvest field observations were made for 820 samples on the August 1 survey, 1,487 samples in September, 1,453 samples in October, and 986 samples in November. Information from these samples was used to prepare current monthly forecasts of yield by states and to improve parameters to be used in the 1968 Operational Program. Additional analysis, to develop new techniques for predicting the average weight of beans per pod, has led to a two-way classification of soybean samples by maturity categories and by groups of varieties. Further refinements of the criteria used in determining maturity categories were made. These refinements were based on information from the weekly observations taken in previous years and from relationships observed for the regular monthly samples.

2. Winter Wheat - The principal objectives of the 1967 winter wheat research were to (1) investigate the relationship between the area of flag leaf early in the growing season and weight of grain per head at maturity, and (2) to measure the correlation of soil characteristics, such as fertility and moisture, with the yield of grain at harvest. Weekly observations were taken in three sample units in each of sixteen fields, eight in Oklahoma and eight in Montana. These observations started when the flag leaves first appeared and continued until the fields were harvested. Counts of total stalks, of stalks with partially emerged heads, and of stalks with fully emerged heads were made in 2 rows of each sample unit. In addition, the length of flag leaves for plants in a 6-inch row section adjacent to each sample row was recorded. Flag leaves in a special clip section near the sample unit were clipped and sent to the state office laboratories for more detailed measurements.

One point of concern was the amount of shrinkage (in area) that occurs as the flag leaf dries. The flag leaves were taped to cardboard and photographed using a thermofax copy machine when they arrived at the state office. When the leaves had dried, the area of the dried leaves and the



copies of green leaves were measured using a planimeter. Unfortunately, the copying machines either magnified or reduced the size of the image depending upon the control settings. The shrinkage that may have taken place was so small that it could not be distinguished from the effect of the copying machines. Analysis to examine the correlation between the planimetered areas and the corresponding length and width measurements is now underway.

Soil samples were also taken at biweekly intervals during the growing season. These samples were taken from the following sections of the soil profile: First six inches, second six inches, second foot, third foot, and fourth foot. First, judgment determinations of soil type and relative moisture content were made by field office personnel. The soil samples were then put through a series of objective laboratory tests to determine the exact moisture content, pH, mineral content, and particle sizes. Subjective evaluations of the soil by relatively untrained field office personnel were not very consistent. Correlation of the laboratory data, for soil samples, with the weight of threshed grain from the corresponding sample units indicates that observations taken in the first foot of soil were the most valuable. Further analysis of the 1967 soil test data is continuing.

Field work in the spring of 1968 involved taking leaf area measurements and soil samples in every tenth regular objective yield winter wheat field in Montana at the time of the regular monthly survey. These data will be analyzed during the coming year.

### 3. Deciduous Fruits - Work in the spring of 1968 involved:

(1) Further testing and refinement of techniques used for counting and estimating apples and peaches in 1967, (2) application of new procedures developed as a result of the experience of 1967, and (3) a test of the extension of these techniques to other fruit crops. Samples of trees were taken in selected peach and apple orchards in northern Virginia, peach and almond orchards in California, and tart cherries in Michigan. In each of these orchards, trees were stratified by trunk size (cross sectional areas) since there is a significant correlation between trunk size and total fruit. A systematic sample of trees was taken within each stratum. Stereo color slides were taken from opposite sides of sample trees in the early spring before the trees had started to leaf out. Sketches which identified every possible sample limb on each side of each sample tree were prepared from the stereo slides. In June this identification for each tree was checked out by actual measurements of all the limbs on the trees. The fruit on each sample limb identified was counted and the actual numbers recorded.

Analysis of similar work in 1967 indicated that sampling terminal limbs with probability proportion to cross sectional area (either multi or single stage) is more efficient than multistage with equal probabilities, but that single stage sampling of terminal limbs with equal probabilities is nearly as efficient. This year the same analysis will be done to determine if this pattern holds over years. The significance of this finding has two important aspects: (1) If sample limbs are selected in the orchard by direct observation, multiple stage sampling of limbs requires much less time and is thus more efficient than single stage sampling; and (2) if sample limbs are selected from sketches of the sample trees, single stage sampling of terminal limbs with equal probabilities is more efficient than sampling limbs with probabilities proportional to size. The use of black and white photographic enlargements of color slides instead of hand-drawn sketches is also being tested.

A second set of photographs of the sample trees was taken at the same time that the fruit counts were made. The 1967 study indicated that fruit counts made from such photographs were highly correlated with the actual counts of the total fruit on the trees. In the future the emphasis will be on determining the possibility of counting only portions of the trees and other ways of reducing the costs of making the sample fruit counts required to estimate numbers of fruit per tree.

4. Hay Forage - Observations were made in twelve alfalfa mixture fields in two counties in Iowa to test procedures developed in previous years to forecast forage production and to develop procedures for determining harvesting losses. The survey plan called for three preharvest visits between the first and second cuttings of hay. These were timed at four weeks, two weeks, and a few days before the expected cutting date. Additional visits were made when the hay was being baled and again a few days later to check on harvesting losses.

Due to labor difficulties and farmers cutting their hay earlier than expected, the complete sequence of visits was made for only six of the twelve fields. On each of the three preharvest visits, ten randomly located sample plots in each field were clipped and weighed. Each plot was 30 inches wide and 20 feet long. Samples of hay from each plot were also tested for moisture content so that the field weight of hay clipped from the sample plots could be adjusted to an equivalent dry weight basis. At harvest, samples of hay were taken from windrows for moisture determinations, the bales were counted, and a sample of bales was weighed. A few days after harvest, 20 three foot square plots were gleaned in each field in an attempt to estimate the amount of hay left by the baler.



Growth curve calculations from the preharvest visits indicated that the amount of hay in the field increased at an average, almost linear, rate of 71.4 pounds per acre per day during this four week period. This was very close to the 69.7 pound growth rate observed in 1966. Attempts to estimate the harvesting loss directly from postharvest gleanings failed because the gleanings contained a considerable amount of residue from previous cuttings, and because the gleaning procedure could provide no information as to the quantity of leaves lost in the curing and baling procedures.

## B. Survey Methods

1. Area Frame Construction - Revision of the Iowa Master Sample Materials was started by the Statistical Laboratory at Iowa State University. The revised area framework is to be patterned after the existing Master Sample Materials with some important modifications. Some refinements of the original frame have been included in the specifications: (1) Count units delineated will carry identifying information for both area and number of farm headquarters (or population). (2) The determination of areas to be called Nonopen Country will be based largely on the density of residences as shown by recent aerial photography. (3) Boundaries used are to be suitable for closed segment surveys. (4) There shall be stratification by broad classes of agricultural use. (5) All numeric data for count units are to be suitable for punching on cards. One county (Story) was completed and will be reviewed before additional work is done.

Progress was made in refinement of the new area frame in the 11 western states. In Strata I and II count units were constructed and number of sampling units assigned for roughly one half the total area. This was done directly on the framework maps using aerial photography as reference where necessary. Some count units were constructed also in Stratum IV B (rangeland). The work in the rangeland stratum is more difficult and time consuming because county highway maps and photography do not provide sufficient information for boundaries. Functional boundaries must be obtained from local sources such as county assessor's office and Bureau of Land Management District Offices. In this stratum it is necessary for count unit and sampling unit boundaries to be adapted to the differing patterns of operation, ownership and/or administration of land. In the 11 Western States, 1,008 segments of the 1,000 series in Strata I and II, were rotated out of the sample to give respondents relief from repeated sampling. The scheme developed for this utilizes the newly constructed count units and also provides for three additional future rotations. In California, Oregon and Wyoming 32 segments in Stratum IV B were rotated.

A research project was instituted to determine the feasibility of alternative ways of associating farm headquarters of nonresident operators of agricultural tracts with area segments. Florida, Pennsylvania, Ohio, and Oregon were chosen for a research survey. From each of them, city maps were obtained for each city (or city area) selected. On these maps a boundary was drawn around the area judged to be residential, commercial or industrial. Boundaries were placed on features expected to be completely identifiable on the ground. The survey design was incorporated into the 1968 June Enumerative Survey for test purposes. For nonresident agricultural tracts, if the operator's residence fell within the specially defined city stratum, the farm headquarters was fractionally associated with the sample segments in the open country where the farmland was located. A questionnaire listing data for the whole farm was obtained from the operator. Data from these questionnaires are being analyzed using a weighted segment estimator.

2. Use of Lists as Sampling Frames - Research work in the use of lists as sampling frames for collecting data on the characteristics of farm operations is being continued by SRS. Problems of identifying proper sampling units, updating, and maintaining lists are of immediate concern.

Ways of obtaining lists of farm operators for agricultural items of minor importance were studied in the states of Illinois, New Mexico, Tennessee, and Oklahoma. The techniques used was the "snowballing" procedure. This procedure utilized a starter list of producers for a minor commodity in attempting to develop a more complete list of producers of the commodity. Questionnaires were mailed to the starter list to inquire or ask for names of other producers of the same commodity. Field work was carried out by SRS in the above states in cooperation with Iowa State University. The minor items investigated were Christmas tree growers in Illinois, beekeepers in Tennessee and Oklahoma, and apple producers in New Mexico. There were three "rounds" (of mailings and interviewing) completed during fiscal year 1968.

Round 1: Questionnaires were mailed and nonrespondents were interviewed from the starter list.

Round 2: New names reported from Round 1 were interviewed.

Round 3: Additional new names reported from Round 2 were interviewed. Analyses for this survey have not been completed.

Another list frame technique developed by Iowa State University was tested in Tennessee and New Mexico. This procedure involves selection of a sample of cities and a sample of rural postal routes within these cities. Box-holders receiving mail on the selected routes were sampled. Mailings were



sent to selected routes and nonresponse followups were made. Experience was needed in applying the procedure under varying conditions of farm density and mail delivery patterns. Results of this project will be analyzed in FY 1969.

Another project involving mailing addresses was conducted in conjunction with the June Enumerative Survey. The objective was to obtain estimates of the amount of agriculture associated with those farmers receiving mail on rural routes, at post office boxes, by city delivery, etc. To identify the place and method of receiving mail, enumerators obtained a supplemental questionnaire during the June Enumerative Survey interview listing all the ways each operator received mail. The information was coded for a number of categories for each survey respondent. The agricultural data (crop acreages, livestock numbers and other farm characteristics) will be tabulated for each of the categories.

One of the major problems in working with lists in survey sampling procedures is the maintenance of an up-to-date list. This problem has been given major emphasis in research work this past year. Along with this, the problem of maintaining lists for SRS use has also been investigated. Research work was done in the states of Oklahoma and Tennessee. In Tennessee, extensive work was carried on in an effort to update a Farm Operator List. This is a relatively large list and the need to solve the problems of updating such a list is urgent. A system of continual updating is being investigated to handle frequent changes in the list using ADP equipment. Another list investigated was the tax assessor's list for designated counties in Oklahoma. Problems of effectively maintaining lists of farm operators in these two states have not been completely resolved. Work is continuing in this phase of the research.

Analyses of data from surveys made in June 1967 in Illinois, New Mexico, Oklahoma, and Tennessee regarding the use of a multiple frame estimator produced some interesting results. Results favored the use of the ASCS Wool Incentive Payments list together with an area sample for estimating sheep characteristics on a state level. For most characteristics, the multiple frame estimator showed considerable improvement in precision compared with an area sample alone. Incompleteness in this list was not extensive, however further investigation indicated that the use of a composite list covering more than one year would be advantageous. It seems that many operations appear on the list one year and not the next, and vice versa.

Multiple frame estimation of poultry items indicated improvement over estimates from the area frame only, but problems arising with the identification of all segments of large operations showed the necessity for further investigation of sampling units as previously described. In estimating cattle numbers, the problems of using large lists, keeping them up-to-date, and maintaining them are extensive.

A small quality check subsample was drawn for chickens and sheep, and respondents were reinterviewed. Results were not conclusive due to the small sample size, however differences in reported data for individual sampling units reveal some rather large response errors in the reported data for the same farms. The differences detected were due to uninformed or improper respondent being interviewed, wrong farm operation recorded, incorrect information given for one or more questions, and reporting incorrect data for the operation or sampling unit.

Work has continued on developing a system of identifying possible duplications in a large list of farm operations. A computer program for the Illinois State Farm Census list is being developed. Detection of duplication will be based upon comparisons among list units on first name, last name, zip code, township, county, and crop reporting district.

#### RPA 113 - REMOTE SENSING

##### Aerial Photography

In 1967 two aerial photo surveys were conducted, however, neither was analyzed until FY 1968. One was conducted in the Sacramento Valley of California, and the other in Tippecanoe County, Indiana.

The California study was oriented primarily toward livestock. The analysis showed a tendency for interpreters to overcount sheep. On the other hand, cattle counts made from photos were less than the ground truth counts obtained by personal observation and ground level pictures. Aerial photo counts for all species were greater than the ground truth counts in the cultivated stratum but not as large in the range. Very little difference in number of animals counted was detected between large scale color photos and black and white stereo photos. However, the large scale color negatives were faster and easier to interpret. Large scale is also needed for making counts of animals tightly clustered and to detect small calves or lambs. The study indicated better boundaries for sample segments would be desirable to be sure animals cannot move in or out of the segment between the time of enumeration and the making of aerial photographs. Also, if aerial photography is to become a part of the livestock estimating process, more efficient means of data handling and photo interpretation will have to be developed.

Very little information was obtained from the Tippecanoe County survey because complete photo coverage could not be obtained due to unfavorable weather conditions. However, from the photos that were obtained, it was possible to identify soybeans and corn at a scale of 1:20,000 on August 1. In late June it was possible to differentiate row crops from cereal crops. Swine are extremely difficult to identify on aerial photos.

Statistical aspects of aerial photo interpretation were studied by the Institute of Statistics at Texas A&M University under a cooperative agreement between the USDA and that Institute. A small set of typical data was obtained from the ARS Remote Sensing Laboratory at Weslaco, Texas. The data consisted of responses to four channels of density readings (no color, red, green, and blue filters, respectively) for five sites of fields on grain sorghum and cotton on four different dates.

Preliminary work included an analysis of variance, using the reading from each channel as the "Y" values, and Hotellings  $T^2$  test. The separate analyses of variance for data from each channel included effects for crops and maturity within crops, however, no statistical significance was found. This is an indication that either the appropriate model was not used or that the volume of data was insufficient. One handicap in this analysis was the lack of clarity for the stage of maturity of the crops studied. Additional data will be analyzed similarly as it becomes available.

The second analysis was conducted to see if the average of the readings from the four channels differed for the two crops. Due to the number of observations, the readings were classified by crops only without regard to stages of the maturity. The Hotellings  $T^2$  test showed no statistical difference. This analysis did reveal that readings from the clear, blue, and green filters are highly correlated. The analysis indicated that larger sample sizes would be needed to allow the use of more comprehensive statistical models that would produce more meaningful results. The analysis also indicated possible changes in data collection, area sampling, and statistical estimating procedures are needed.

#### Publications - USDA and Cooperative Program

The research is primarily for internal use. No results were published during the year in journals or as articles generally available in libraries.

